

**Effects of the invasive aquatic plant, *Egeria*
densa, on native fish habitat in the
Sacramento–San Joaquin Delta**

#0035

Technical Panel Review

Proposal Name: Effects of the invasive aquatic plant, *Egeria densa*, on native fish habitat in the Sacramento–San Joaquin Delta

Applicant Organization: California Water Science Center, U.S. Geological Survey

Principal Lead Investigator(s):

Drexler, Judith

Brown, Larry

Wright, Scott

David, Schoellhammer

Amount Requested: \$790,863

TSP Panel Summary of Findings:

This proposal is very much at the heart of what interests CalFED. The San Francisco Bay Delta is one of the major areas of concern to CalFED. The topic involves aquatic invasive species, habitat and organism survival, which are all key components of the effort to restore the Bay. While there are many strong points in favor of this proposal, two of the three reviewers identified some serious shortcomings. Most of these involve a sampling plan that may fall short of the desired goals. With a relatively small number of dataloggers (sondes) and the need to move them from location to location, there is legitimate fear that after spending almost \$800,000 the results on the impacts of the Brazilian waterweed might be hard to decipher. Perhaps investigators should purchase more than 2 sondes given the wear they may encounter (e.g., fouling). Further, one reviewer correctly points out that the approach for developing the sediment transport model is unclear. Finally, the connection between the results from studying the Brazilian waterweed and its impact on other organisms is tenuous and may be more correlative rather than cause and effect. There is serious concern that the cryogenic coring procedure will not work in the deeper channels with high currents.

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Additional suggestions for proposal revision: 1) Revise the conceptual model based on the soon-to-be completed Delta SAV conceptual model being prepared by DRERIP and lead by USDA. 2) Consider making some changes to the study to provide more depth to the questions under study. 3) Identify the linkages to POD research and researchers to address external reviewers comments regarding lack of fish sampling. 4) The researchers have overstated the predicted geomorphic outcomes and thus must evaluate how well suited the numerical modeling is to the smaller expected changes. 5) Reword Hypothesis #3 and use it to support the sedimentation field component. 6) There is a possible solution to the concerns of the external reviewers over approach and feasibility of measuring sedimentation and scour in the Egeria beds - bed level sensors (Peter Ridd, Australia). 7) Consider whether to remove the numerical model component. 8) Refine site selection criteria to address reviewers' comments and to disconnect tight linkage to channels to support evaluating flawed hypothesis #3. 9) Utilize Technical Review of Revised Study Plan.

The panel recommends that applicant make changes stemming from suggestions given above and resubmit at a later date.

Relevance to PSP Topic Areas:

High

TSP Technical Rating:

Sufficient

TSP Funding Recommendation:

Do Not Fund

TSP Amount Recommended: \$0

Conditions:

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Proposal Title: Effects of the invasive aquatic plant, *Egeria densa*, on native fish habitat in the Sacramento–San Joaquin Delta

Proposal Number: 0035

Proposal Applicant: California Water Science Center, U.S. Geological Survey

Purpose

Comments	<p>The purpose of the project is to evaluate the impact of <i>Egeria densa</i> on native fish habitat in the Delta. The authors propose to accomplish this purpose by measuring abiotic water quality parameters (Temp, DO, suspended solids) inside and outside of <i>E. densa</i> beds of varying size classes. The second component of the project is a sediment transport model of the Delta, augmented with a function to estimate sediment deposition inside and outside of <i>E. densa</i> beds. This model will be developed for three levels of <i>E. densa</i>: complete removal, current densities, and 100% coverage of potential <i>E. densa</i> habitat. The model will then be further developed to predict changes in habitat availability over the next century as channels migrate and/or fill.</p> <p>The proposal is well written and the goals, objectives and hypotheses are clearly stated. The idea is timely, in that <i>E. densa</i> is currently the aquatic invasive plant of greatest concern in the Delta and it is expanding rapidly throughout available habitat. Previous research suggests that <i>E. densa</i> has impacts on important abiotic properties that may dictate habitat availability and thereby survival of desired fish species. The scale of the project is justified given the available data, but I have some concerns about the methods chosen and the feasibility of the project. If successful, the project will contribute to our knowledge base about the impacts of <i>E. densa</i> (and</p>
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	<p>similar invasive plants) in the Delta. Likewise, a working model of sediment transport in the Delta will be useful for several other predictive purposes in the future. The application of this model to fish habitat is related to the ideas that certain species favor high turbidity environments and that if left unchecked <i>E. densa</i> may cause channels to fill in. This relationship will need to be made with care. This type of model is currently lacking and will be an important addition to Delta predictive capacities. The main result of Part 2, which evaluates abiotic properties in the Delta, will be information on the size dependence of <i>E. densa</i> patch sizes. Other effects of <i>E. densa</i> (altered DO regimes, temperature, etc...) have already been well studied and this won't add greatly to our knowledge base.</p>
Rating	Above Average

Background

Comments	<p>The conceptual model is laid out clearly in the text and describes the rationale for measuring the selected abiotic parameters (i.e. <i>E. densa</i> impacts abiotic parameters that may in turn impact fish). How the results of the abiotic parameter study will be interpreted to explain potential impacts on fish abundance isn't as clear to me, but perhaps this will be by comparison with previous work by the authors on fish densities, predation, competition, etc... inside and outside of <i>E. densa</i> beds. It might be nice to see a little more information on the specifics of how the results will be interpreted. Alternatively, some idea of fish densities in different <i>E. densa</i> patch sizes (from previous work or as a part of this study) would have been helpful. i.e. if the abiotic factors vary with patch size, does fish density also vary with patch size? This would help to corroborate the hypothesis that the presence of <i>E. densa</i> inhibits native fish presence.</p>
Rating	Above Average

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Approach

Comments	<p>I have some more serious concerns about the approach taken in the proposed work. 1. The authors propose to select 2 replicate patches from each of 3 patch sizes. Are 2 replicates sufficient? They state that they need to do 2 for appropriate statistical comparison, but I'm concerned that this level of replication isn't sufficient for the proposed statistics (t-tests of within patch size effects). I believe that the number of sites is limited by the requested number of hydrosondes and ADV sensors. However, given the already very large nature of the budget and the potential for excellent quality data, perhaps it would make more sense to purchase additional sensors to ensure that the results are internally consistent and not subject to intersite differences. This is also related to my comments in #3 below.</p> <p>2. Are any other measurements planned to ensure similarity between patches of similar size? It may be important to look at plant density, height, etc... which may vary substantially between regions of the Delta depending on local environmental factors such as water depth, nutrient availability or sediment load (which could decrease photosynthesis if sufficient sediment accumulated on fronds).</p> <p>3. The sampling will be conducted using hydrosondes suspended at two sites at a time, and then rotated through the remaining four sites on a monthly basis. This will give approximately "seasonal" values for each site. I'm concerned that this mode of sampling may give results that vary substantially between sites not because of intersite differences, but because of differences in the time of measurement. This may be especially true during times of significant climatic change (spring or fall) or during times when <i>E. densa</i> productivity increases substantially over a short time period (summer). Thus, the hypothesis that patch sizes have a significant impact may be accepted, when indeed</p>
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	<p>it was a difference in sampling time between sites creating the observed differences. The authors mention using tidbits to look at vertical stratification of temperature during the monthly samplings. Perhaps these could be used to intercalibrate between sites - i.e. deploy these at all times at all sites, and compare between the hydrosonde measurements and the tidbit data across sites. This would only work for the temperature measurements, but could potentially be extrapolated to other abiotic measurements. If this type of intercalibration is planned, it is not clearly described in the proposal.</p> <p>4. The approach for coming up with the sediment transport model is a bit unclear and seems to leave a lot to be determined in the future. It sounds like several existing models will be investigated for use as a starting point for the model, and that the sediment properties will be added into these models. It would have been nice to see a little more certainty about the starting point for this important aspect of the work.</p> <p>Project management and administration seems feasible and well planned. If successful, yes, products of value will stem from this work. This is particularly true of the sediment transport model. This will be a useful tool for future investigations in the Delta. I would like to see more than 2 expected publications coming from a million dollar project, but I suppose if the publications are of great impact, then 2 is sufficient. Other modes of information dissemination seem sufficient.</p>
Rating	Sufficient

Feasibility

Comments	For the most part the approach is fully documented and feasible. As stated above, the one aspect that isn't entirely clear is the approach for the sediment transport model, which
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	appears to have some aspects that will be worked out as part of the proposed project. Aside from the methods concerns stated above, if those aren't an issue there is a high likelihood of success. The scale of the project is consistent with the objectives and the authors are qualified to conduct the work.
Rating	Above Average

Budget

Comments	Most of the budget is devoted to salaries, which are by nature costly. Thus, the budget seems reasonable for the scope of work proposed.
Rating	Superior

Relevance To CALFED

Comments	Yes, the proposal addresses priority 2 (invasive species) and priority 4 (habitat modification). The proposal fits well into CALFED's goals and makes use of existing CALFED data and other projects. If successful, the project will contribute important information about the relationships between E. densa invasion, fish habitat, and overall hydrodynamics of the Delta.
Rating	Superior

Qualifications

Comments	The project team is eminently qualified to carry out the work. Each scientist has prior experience working in the Delta and is able to contribute well to the individual components of the project. The infrastructure necessary to carry out the project is contained within USGS and there are few stumbling blocks in this aspect of the proposed work.
Rating	Superior

External Technical Review #1

Overall Evaluation Summary Rating

Comments	This is an interesting and pertinent project that seeks to address issues important to ecosystem health in the Delta. As previously described, I have some concerns about the methods proposed that should be worked out prior to instituting the planned research.
Rating	Above Average

External Technical Review #2

Proposal Title: Effects of the invasive aquatic plant, *Egeria densa*, on native fish habitat in the Sacramento–San Joaquin Delta

Proposal Number: 0035

Proposal Applicant: California Water Science Center, U.S. Geological Survey

Purpose

Comments	<p>Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?</p> <p>The goal of this project is to determine quantitatively the abiotic ecosystem effects of an invasive species, <i>Egeria densa</i>, at the Sacramento-San Joaquin Delta system.</p> <p>Is the study justified relative to existing knowledge?</p> <p>Yes. There seem to be only qualitative data on these effects to date.</p> <p>Is the selection of research, pilot or demonstration project, or a full-scale implementation project justified?</p> <p>Yes. This colonizing specie continues and spreads in the system and a quantitative assessment of its impact is lacking.</p> <p>Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches?</p> <p>Result will increase knowledge about the effects of nuisance species. Methodology and approach are not novel but their combination into an interdisciplinary</p>
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	study is novel and noteworthy.
Rating	Superior

Background

Comments	<p>Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Yes. The conceptual model relates E. densa to temperature dissolved oxygen, turbidity, water velocity and sedimentation. The relationship depends on the spatial scale of the E. densa colony. The larger the colony the larger the effect. In short, E. densa likely causes increase temperature and temperature gradients, reduces turbidity, decrease water velocity, increase sedimentation and increase fluctuations in DO. These aggregate effect is a change in habitat which is likely to make the channels colonized by E. densa less suitable to local fish species. Is all other information needed to understand the basis for the proposed work included and well documented? Yes. The background material is presented well showing how this work builds on current knowledge. The proposal is well written.</p>
Rating	Superior

Approach

Comments	<p>Is the approach well designed and appropriate for meeting the objectives of the project? Yes. Given obvious constraints, this proposal achieves a good balance between obtaining information at the appropriate temporal scales (e.g. tide resolving), spatial scales (inside and outside the patches, variety of patch sizes (3)). Is it clear who will be performing management tasks and administration of the project and are resources set aside to do so? Yes, the project management is laid out well and is clear. Are products of value likely from the project? Absolutely. A quantitative understanding of the impact of E. densa on the Delta is likely to emerge from this study. Is</p>
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	there a plan for widespread and effective dissemination of information gained from the project? Yes. Scientific publications and presentations at a CALFED conference. Are contributions to larger data management systems relevant and considered? These will follow naturally from the above dissemination efforts.
Rating	Superior

Feasibility

Comments	<p>Is the approach fully documented and technically feasible? The approach is fully documented and feasible. All aspects, from the field to the modeling are well thought of and clearly laid out. What is the likelihood of success? High. Given the exploratory nature of the work any result should be consider as positive as it provide a needed quantitative baseline for understanding the effect of E. densa. Is the scale of the project consistent with the objectives and within the grasp of authors? Yes. The authors are well qualified to execute this project. Some comments on the approach (non of which is a show stopper, mostly things to think about): 1. I have problem with replicate pairs as they provide very little information on the likely environmental variance. Triplicate are strongly encourage, though they do increase the work load significantly. 2. Depth should be as important as horizontal scale. Make sure your control have the same depth. 3. YSI O2 sensors have had mixed results. Consult the Alliance of Coastal Technology's latest inter-comparison of DO sensor to see if its characteristics are best suited for your needs. 4. An interesting potential problem is that of the feedback between colonization by E. densa and changes in the delta dynamics. As channel choke up the water will need to move and open new</p>
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	channels to flow through. These will take time to get colonized and may provide temporary refuge to local fish.
Rating	Above Average

Budget

Comments	Is it clear how much each aspect of the proposed work will cost including each task, salaries, equipment, etc.? The budget is clearly outlined. Is the budget reasonable and adequate for the work proposed? The budget is reasonable. In addition significant cost saving is achieved through the cost share with USGS.
Rating	Superior

Relevance To CALFED

Comments	How well does the proposal address the priorities stated in the PSP? This proposal addresses two topics: Aquatic invasive species (E. densa is one) and Habitat availability and response to change (The effect of colonization by E. densa likely affects Habitat quality and availability to local species). Does the proposal clearly and directly address one or more of the topics in the Priority Research Topic List? Yes, Topic 2 and 4 as detailed above. Does the proposal address other priorities stated in the PSP such as integration, syntheses, use of existing information, multiple disciplines or modeling? The proposal is interdisciplinary, integrating disparate academic fields to address an acute problem. The proposal builds on existing information on the colonization by E. densa and some knowledge of its likely effects to design a field program from which, using modeling, the effect on the whole Delta can be estimated. Will the information ultimately be useful to CALFED resource managers and policy makers? Absolutely. Decisions regarding mitigation effort needed to address E. densa in particular and other invasive species in general will be better informed following this study.
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Rating	Superior
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Qualifications

Comments	What is the track record of authors in terms of past performance? The combined authors are active and have an impressive history with CALFED and other funding agencies. They publish their results regularly and in respected journals. In particular, the relatively young lead PI as an impressive record in leading a large scientific project. Is the project team qualified to efficiently and effectively implement the proposed project? Yes. Do they have available the infrastructure and other aspects of support necessary to accomplish the project? Yes. Facilities are more than adequate to execute the proposed project both in access to hardware and expertise.
Rating	Above Average

Overall Evaluation Summary Rating

Comments	I rate this proposal as Superior. It will provide important base line quantitative information about an engineer invasive specie, E. densa, which is modifying channels within the Scaramento -- San-Joaquin Delta. Modeling will allow scaling the effect to the whole Delta. This information is critical to assess habitat health and likely modification needed for long term planning and mitigation.
Rating	Superior

External Technical Review #3

Proposal Title: Effects of the invasive aquatic plant, *Egeria densa*, on native fish habitat in the Sacramento–San Joaquin Delta

Proposal Number: 0035

Proposal Applicant: California Water Science Center, U.S. Geological Survey

Purpose

Comments	The goals and objectives of the project are clearly stated - to understand the impact of <i>Egeria</i> on abiotic conditions in the Delta and assess how those conditions impact habitat for several POD species. The hypotheses are related to the goal. The inclusion of channel morphology in this project is, however, poorly justified and not linked well to other components. Some of the work, if successful, would undoubtedly increase our knowledge of the effects of <i>Egeria</i> on delta water bodies - something over which we have hypothesized for some time but except for the (as yet unpublished work?) of Stacey's group we have made little progress.
Rating	Sufficient

Background

Comments	The CMs are broken out into temperature, dissolved oxygen, velocity/sedimentation and turbidity. The temperature and DO models are quite clear and seem to be based on some observations in the system (mostly Grimaldo and Hymanson). There is some confusion in the DO model where splittail are mentioned as tolerant of low DO and then described as sensitive. The seasonality hypothesized in the DO model seems to be dependent on growth form of the plant by season but it is poorly described. The water velocity and sedimentation model is weak. It seems to be mostly based on SAV work in streams or emergent tidal
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External Technical Review #3

	<p>macrophytes. The relationship between seasonal changes in phenology and sediment supply is not discussed, scour is mentioned only in passing but will not be measured here, and there is no distinction between trapping of suspended sediment and the accumulation of organic detritus with the Egeria beds. The methods suggested are especially weak (see below). The turbidity model is based on little actual observation. The effects of patch size, density, seasonal growth form are not mentioned and there is a confusing discussion of phytoplankton - if the Egeria is making clearer water why aren't we seeing higher phytoplankton growth? The relationship to POD species is clear for temp and DO models but not for velocity/sed and turbidity models.</p>
Rating	Inadequate

Approach

Comments	<p>It is clear who is responsible for administering the effort, although it would seem to be that a scientist is not the best person to be spending many hours on contract management. The field component of the approach lacks a clear experimental design. Sites have not been picked or really specifically suggested. Given the team is already working on Egeria for IEP this seems odd. There is no definition of small and medium sized channels, although the San Joaquin River at Venice Cut is suggested as a study site (if this is medium, what is large?). Figure 1 does not show the sites mentioned in the text and but shows others, including flooded island locations like Sherman, so does not support this topic well at all. The field approach often refers to inside and outside of patches with no indication of how far 'inside' from the margin is going to be, how that might vary with size, or how depth will be considered. Are all Egeria beds of similar density? There is mention of TidbiT sensors but these are not budgeted and the use of them seems vague (e.g., larger beds get more TidbiTs - why?). There seems to be a problem with the method for</p>
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	<p>sedimentation. The method is described is mostly used in intertidal and shallow subtidal environments. It seems likely that these channels sites will be ~ 1m in depth or perhaps more. There is not mention of how markers will be placed through such water depths (divers?), how they will be relocated for sampling, and how cryogenics will be used though such a lot of water - the heat losses through the water column will be enormous. Also I assume this sampling will be conducted from a boat - not a stable platform as was used at Twitchell. I just do not see how this will work. There is also the problem of detecting sediment trapped by the Egeria and organic detritus - lab analysis is not described. And marker horizons cannot be used to detect scour - mentioned in the CM but not measured here, and likely an essential component of the inside-outside comparison. The modeling seems out of place in this proposal. This section implies that with spreading Egeria channels could gradually fill to high tide with sediment. I am not sure where the Egeria grows under these conditions! The modeling would need clear rules about where Egeria grows and does not and how it interacts with the channel hydrodynamics (e.g., to constrain flow, increase velocity and allow high velocity areas to remain unvegetated?). It has to be more than just sedimentation - there needs to be a dynamic feedback to the growth of Egeria for this to be valid. I do support the linking of tidal time scale models with morphological change on decadal time scales. This approach is clearly the way to go in understanding change in morphology but I am not convinced that the model will be sufficiently parameterized by Egeria to accomplish the task set forth here. Also - there is no measurement effort for fish. How the effects on habitat for species are to be verified is not clear.</p>
Rating	Inadequate

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Feasibility

Comments	I believe such a project could be carried out and may provide important information. I do not think this is the proposal to do it. The team needs an expert on Egeria dynamics, and to be more realistic about what the modeling can contribute. It would be preferable to develop a more localized predictive tool linking Egeria growth, hydrodynamics and morphological change, and fish use.
Rating	Sufficient

Budget

Comments	The match from USGS makes the budget reasonable. I question why all the fieldwork seems to be done by PIs without graduate assistants, or routine field support. Half time for two senior PIs implies they will be spending a lot of time in the field and there are likely more cost-effective ways to get much of the routine work done.
Rating	Sufficient

Relevance To CALFED

Comments	Egeria is certainly an area needing more work and this fits with the topic on Invasive species. The link to POD is very weak.
Rating	Sufficient

Qualifications

Comments	This is a good team but I think they are stretched a little by what is proposed and appear lack experience with SAV ecology. They all have a good record of both publishing scholarly papers and communicating effectively to managers about their work.
Rating	Above Average

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Overall Evaluation Summary Rating

Comments	I think most of this is a good idea, the modeling seems misplaced, but the project is simply not well enough thought out as far as field design and methods for me to have confidence in the outcome.
Rating	Inadequate